

a second thin film transistor having a second active layer comprising silicon formed over said underlying layer wherein said second active layer is not intentionally doped with germanium.

50 (New). The semiconductor device according to claim 49 wherein the underlying film is silicon oxide.

REMARKS

Applicants have amended Claims 31 and 33 to correct a typographical error in each, changing "fist" to -- first -- .

Applicants will now address each of the Examiner's rejections in the order they appear in the Final Rejection.

§112, First Paragraph Rejections

In the Office Action, the Examiner continues to reject Claims 30-38, 41-43 and 46-48 under 35 USC §112, first paragraph, as allegedly

"...containing subject matter which was not described in the specification in such a way as to reasonable convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention."

In particular, the Examiner contends that the specification does not describe first and second thin film transistors wherein the semiconductor film of the second thin film transistor contains germanium and the semiconductor film of the first thin film transistors is not intentionally added with germanium and a concentration of germanium in the semiconductor film of the second film transistor is higher than a concentration of the semiconductor film of the first thin film transistors, as recited in independent Claim 30. Instead, the Examiner argues that:

“...the specification discloses that the semiconductor films of claim 30's [and the claims dependent thereon] first and second thin film transistors consist of silicon (Si) and silicon germanium (SiGe), respectively. See the specification at page 8, lines 13-21, for example.”

Applicants respectfully traverse this rejection.

As disclosed in the specification (see e.g. page 5, lns. 14-27 and Fig. 1) in an embodiment of the present invention, a display device of an active matrix type comprises a pixel matrix circuit 101 and a gate driver circuit 102 (and other elements). The pixel matrix circuit 101 is formed of a polysilicon film. The driver circuit has a TFT group active layer using a polycrystalline silicon germanium film. Id. The polysilicon germanium film is formed by selectively adding germanium. Page 5, lns. 27-30. Before the germanium is added, a resist mask is formed over those regions, such as the pixel matrix circuit, where it is not intended that germanium should be added. The germanium is then added to regions such as the driver circuit. See page 6, lns. 16-25.

Accordingly, the specification clearly supports the limitation in Claim 30. More specifically, Claim 30 includes the open-ended transitional phrase “comprising”. As is well established in the law, comprising means including the following elements but not excluding other elements. Claim 30 states that the semiconductor film of the second thin film transistor contains germanium. As explained above, it must contain germanium because the specification teaches that germanium is added to the film. The open ended nature of the claim allows for the possibility that the germanium is part of polycrystalline silicon germanium film.¹ Further, Applicants believe that it is undisputed that the semiconductor film of the first thin film transistors of Claim 30 does not intentionally have germanium added thereto (the purpose of the resist described above). As a result, the concentration

¹ The undersigned has reviewed the other specification sections cited by the Examiner in the Final Rejection, i.e. page 8, lns. 13-21, page 6, lns. 26-29 and page 7, lns. 1-4. Each of these sections merely seem to state that there is a poly silicon germanium film (which must contain germanium) which is entirely consistent with the above explanation and Claim 30.

of germanium in the semiconductor film of the second thin film transistor of the driver circuit will be higher than the concentration of any germanium that may have unintentionally been added to the semiconductor film of the first thin film transistor. Hence, this claim language is clearly supported by the specification.

For substantially the same reasons, the similar limitations in the other rejected claims are also supported by the specification. Therefore, it is respectfully requested that this rejection be withdrawn.

The Examiner also rejects Claims 30-38, 41-43 and 46-48 under 35 USC §112, first paragraph, as non-enabling for the same reason discussed above. For the reasons explained above, the specification clearly supports the limitations in these claims, and, therefore, the specification is enabling for those claims. Accordingly, it is also respectfully requested that this rejection be withdrawn.

§112, Second Paragraph Rejections

The Examiner further rejects Claims 31, 34 and 37 under 35 USC §112, second paragraph, as being indefinite. In particular, the Examiner objects to the language in Claim 31 of "wherein the semiconductor film of said plurality of first [sic, see amendment herein, first] thin film transistors is not added with germanium while the semiconductor film of said second thin film transistor is added with germanium." The Examiner makes a similar argument to the one he made above. However, as explained above, the specification clearly explains that the "semiconductor film" of the "first thin film transistor" of the device of Claim 31 comprises silicon, and that by placing a resist over the layer when germanium is being added to the driver circuit ("the semiconductor film of the second thin film transistor" of Claim 31) and other layers, germanium is not being intentionally added to the semiconductor layer of first thin film transistor of this claim. See cites to specification

in section above. Hence, Applicants submit that in light of the specification, this language is not indefinite.

For substantially the same reasons, the other rejected claims are also not indefinite. Therefore, it is requested that this rejection of these claims be withdrawn.

§103 Rejections

The Examiner further has the following rejections under 35 USC §103:

- (a) Claims 2, 5, 11, 14, 40 and 45 as being unpatentable over Zhang et al. '733 together with King et al.;
- (b) Claim 8 as being unpatentable over Zhang et al. '733 together with King et al. and Zhang et al. '277;
- (c) Claims 1, 4, 10, 13, 30-35, 39, 41, 42, 44, 46 and 47 as being unpatentable over Zhang et al. '733 together with King et al.;
- (d) Claims 7, 36-38, 43 and 48 as being unpatentable over Zhang et al. '733 together with King et al. and Zhang et al. '277.

Each of these rejections is respectfully traversed.

The present invention is directed to a semiconductor device such as an active matrix display device having at least two thin film transistors. In accordance with a typical example of the present invention, a pixel TFT connected to a pixel electrode has a channel region comprising silicon which is not doped with germanium (i.e. germanium is not intentionally added to this layer, this can be accomplished by using a resist mask; see *supra* and pages 5-6 of the specification) while a TFT included in a driver circuit for driving the pixel TFT has a channel region comprising silicon which is doped with (i.e. added) germanium (see *supra* and pages 5-6 of the specification). The TFT

having a channel region comprising silicon doped with germanium is suitable for realizing a high field effect mobility.

However, Applicants recognized a problem in that such a TFT tends to have a higher off current due to the large carrier density. Based on the recognition of this problem, Applicants' invention resides in the use of the TFT having a channel region comprising silicon doped with germanium in a selected portion of the semiconductor device depending upon the required characteristics of the circuits.²

The Examiner, however, continues to assert as the primary basis of his rejection that:

“the difference between Zhang et al. (see the entire patent) and the set of rejected claims is their complementary driver circuit transistors are formed in polycrystalline silicon and polycrystalline silicon germanium, respectively”

and that:

“King et al. teach that it is advantageous to form complementary driver circuit transistors in polycrystalline silicon-germanium rather than polycrystalline silicon.”

The Examiner then concludes that:

“[i]t would have been obvious to one skilled in this art to advantageously form Zhang et al's complementary driver circuit transistors (but not its pixel circuit transistors, which Zhang et al. disclose are on a different design footing than the driver circuit transistors), in polycrystalline silicon-germanium rather than polycrystalline silicon, as taught by King et al.”

However, under 35 U.S.C. §103, the burden is on the PTO to produce evidence that the claimed invention is prima facie obvious. In re Rijckaert, 9 F.3d 1531, 1532, 28 USPQ2d 1955,

² Applicants do not understand the Examiner's objection to this recital. As explained above and in the specification, in one embodiment of the present invention, using a resist, Applicants are able to have silicon doped with germanium in a selective portion of the semiconductor device. For example, before the germanium is added, a resist mask is formed over those regions, such as the pixel matrix circuit, where it is not intended that germanium should be added. The germanium is then added to regions such as the driver circuit. See page 6, lns. 16-25.

1956 (Fed. Cir. 1993); In re Fine, 837 F.2d 1071, 1074, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988). If the PTO fails to make out a prima facie case of obviousness, then the rejection is improper, should be overturned, and Applicants are entitled to a patent. Rijckaert, 9 F.3d at 1532, 28 USPQ2d at 1956; In re Nielson, 816 F.2d 1567, 1572, 2 USPQ2d 1525, 1528 (Fed. Cir. 1984); In re Gordon, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984).

It is respectfully submitted that the Examiner has failed to state a proper prima facie case of obviousness. In particular, the Examiner's combination of references to arrive at the claimed invention is improper under the standard set by the Court of Appeals for the Federal Circuit.

As the Federal Circuit has held on numerous occasions, "[w]hen a rejection depends on a combination of prior art references, there must be some teaching, suggestion, or motivation to combine the references." Ecolchem, Inc. v. Southern California Edison Company, 56 USPQ2d 1065, 1073 (Fed. Cir. 2000). "Combining prior art references without evidence of such a suggestion, teaching, or motivation simply takes the inventor's disclosure as a blueprint for piecing together the prior art to defeat patentability-the essence of hindsight." Id. Such hindsight reconstruction is improper, and a rejection based thereon should be withdrawn. Id. at 1072-1076.

In the present case, no such teaching, suggestion, or motivation has been provided in the rejection. Instead, the rejection merely concludes that it would have been obvious to combine these references, but there is no showing where there would have been motivation to do so. Clearly, what the Examiner has done is to pick and choose portions of various references and put them together using the present application as a blueprint. That is a clear example of improper hindsight reconstruction. If not, Applicants challenge the Examiner to show where there is any teaching, suggestion or motivation why one skilled in the art would have combined these references in the manner proposed by the Examiner in the Final Rejection.

In fact, Applicants believe that there is no such motivation to combine. As explained previously, Zhang '733 teaches to selectively add nickel, iron, cobalt or platinum (see col. 2, lns. 43-45 of Zhang '733) for promoting crystallization in a driver circuit TFT, while such a metal is not intentionally used in a pixel TFT. Zhang '733 does not teach that germanium can be used as the catalyst nor, as the Examiner admits, does the reference teach a semiconductor device having a first film transistor with a first active layer of SiGe and a second film transistor with a second active layer of Si, as required in rejected independent Claims 2 and 3.

The Examiner then cites King. King, however, merely teaches to form a Si-Ge film and crystallize it.³

Further, the Examiner contends that King teaches that it is advantageous to form complementary driver circuit transistors in polycrystalline silicon-germanium rather than polycrystalline silicon and then argues that it would have been obvious to one skilled in the art to advantageously form Zhang's complementary driver circuit transistors in polycrystalline silicon-germanium, rather than polycrystalline silicon, as allegedly taught by King.

Applicants respectfully submit that the references teach away from the Examiner's proposed substitution. In particular, King discloses that poly-Si-Ge film is used to crystallize at a lower temperature than poly-Si film (see col. 1, lns. 19-27 of King). However, Zhang' 733 requires poly-Si for the high speed TFTs which are used in the peripheral driver circuit (see column 4, lns. 35-43 of Zhang '733). Hence, there is no suggestion or motivation to combine these references in the manner suggested by the Examiner.

³ Applicants respectfully submit that Zhang '277 does nothing to overcome the deficiencies of Zhang '733 and King.

Therefore, Applicants can only conclude that Applicants' claimed invention is the blueprint for such combination. As this is improper hindsight reconstruction, it is respectfully requested that the rejections based thereon be withdrawn, and the claims allowed.

With respect to the rejections of Claim 8, since this claim is a dependent claim, and as explained above independent Claim 2 is distinguishable over Zhang '733 and King and Zhang '277 dependent claim 8 is also allowable. Therefore, it is requested that this rejection be withdrawn.

With respect to the rejection of Claims 1, 4, 10, 13, 30-35, 39, 41, 42, 44, 46 and 47, these claims are allowable over the cited references for similar reasons as described above for Claims 2, 5, 11, 14, 40 and 45. Therefore, it is requested that this rejection be withdrawn.

With respect to the rejection of Claims 7, 36-38, 43 and 48, these claims are also allowable over the cited references for similar reasons as explained above for Claims 2, 5, 11, 14, 40 and 45. Therefore, it is requested that this rejection also be withdrawn.

For at least the above-stated reasons, the claims of the present application are patentable over the cited references and in an allowable form. Accordingly, it is requested that they now be allowed.

New Claims

Applicants have also added new Claims 49 and 50. For similar reasons as discussed above, these claims are also allowable over cited references. Accordingly, it is requested that these claims be allowed. Please charge our deposit account 50/1039 for any fee for these claims.

IDS

Applicants are also submitting an IDS herewith citing U.S. 6,380,590. It is requested that this IDS be considered before another action is issued. It is possible that there is interfering subject matter between the '590 patent and the present application.

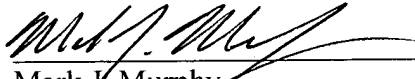
Conclusion

For the above stated reasons, the present application is now in a condition for allowance and should be allowed.

Favorable reconsideration is earnestly solicited.

Respectfully submitted,

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Marked-up copy of claims as amended:

IN THE CLAIMS:

31. (Twice Amended) The semiconductor device according to claim 30 wherein the semiconductor film of said plurality of [first] first thin film transistors is not added with germanium while the semiconductor film of said second thin film transistor is added with germanium.

33. (Twice Amended) A semiconductor device comprising:

a substrate having an insulating surface;

a first thin film transistor formed over said substrate, said first thin film transistor comprising:

a first semiconductor film comprising crystalline silicon formed over said substrate and having a channel region;

a [first] first insulating film adjacent to said first semiconductor film; and

a first gate electrode adjacent to said first gate insulating film;

a second thin film transistor formed over said substrate, said second thin film transistor comprising:

a second semiconductor film comprising crystalline silicon formed over said substrate and having a channel region;

a second gate insulating film adjacent to said second semiconductor film; and

a second gate electrode adjacent to said second gate insulating film,

wherein said first semiconductor film contains germanium at a higher concentration than said second semiconductor film and the second semiconductor film is not intentionally added with germanium.

Please add the following new claims:

49 (New). A semiconductor device comprising:

a substrate;

a underlying layer formed over the substrate;

a first thin film transistor having a first active layer comprising $\text{Si}_{1-x}\text{Ge}_x$ where $0 < X < 1$ formed over said underlying layer; and

a second thin film transistor having a second active layer comprising silicon formed over said underlying layer wherein said second active layer is not intentionally doped with germanium.

50 (New). The semiconductor device according to claim 49 wherein the underlying film is silicon oxide.